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Test report

365522-1TRFWL

Date of issue: March 1, 2019

Applicant:

Applied Concepts, Inc.

Product:

Stalker Ka-Band Microwave Unit

Model:

Stalker II MDR

Model variants:

Stalker products: SDR, International, I w/ fast, I w/o fast, 2X, DSR and Dual SL

FCC ID number:

IBQACMI008

Specifications:

FCC Part 90 Subpart F

Title 47—Telecommunication
Chapter I—Federal Communications Commission
Subchapter D—Safety and special radio services
Part 90—Private land mobile radio services
Subpart F—Radiolocation service

Test location

Company name:	Nemko Canada Inc.
Address:	303 River Road
City:	Ottawa
Province:	Ontario
Postal code:	K1V 1H2
Country:	Canada
Telephone:	+1 613 737 9680
Facsimile:	+1 613 737 9691
Toll free:	+1 800 563 6336
Website:	www.nemko.com
Site number:	IC: 2040A-4 (3 m semi anechoic chamber)

Tested by:	Andrey Adelberg, Senior Wireless/EMC Specialist
Reviewed by:	Kevin Rose, Wireless/EMC Specialist
Date:	March 1, 2019
Signature:	

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

Copyright notification

Table of contents

Section 1. Report summary

1.1 Test specifications

FCC Part 90 Subpart F	Radiolocation service

1.2 Test methods

ANSI C63.10 v2013	American National Standard for Methods of Measurement of Radio- Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
FCC Part 2 Subpart J	Equipment authorization procedures

1.3 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was completed against all relevant requirements of the test standard or as per detailed in the section 1.4 Exclusions below. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See "Summary of test results" for full details.

1.4 Exclusions

None

1.5 Test report revision history

Revision #	Details of changes made to test report
TRF	Original report issued

Section 2. Summary of test results

2.1 FCC test results

Table 2.1-1: *FCC test results summary*

Part	Test description	Verdict
2.1046	Output power	Pass
2.1049	Occupied bandwidth	Pass
2.1051	Spurious Emissions at the antenna terminal	Not applicable
2.1053	Field strength of spurious radiations	Pass
2.1055	Frequency stability	Pass

Notes: EUT doesn't have antenna connector.

Section 3. Equipment under test (EUT) details

3.1 Applicant and manufacturer

Company name	Applied Concepts, Inc.
Address	855 E. Collins Blvd., Richardson, TX 75081

3.2 Sample information

Receipt date	January 4, 2017
Nemko sample ID number	133-002471, 133-002146

3.3 EUT information

Product name	Stalker Ka-Band Microwave Unit
Model	Stalker II MDR
Model variants	Stalker products: SDR, International, I w/ fast, I w/o fast, 2X, DSR and Dual SL
Serial number	AS012614

3.4 Technical information

Operating band	33.4–36.0 GHz
Operating frequency	34.7 GHz
Modulation type	CW
Occupied bandwidth (99 %)	256 kHz
Emission designator	N0N
Power requirements	9–12 V_{DC} from attached battery or car battery. There is no alternate power source.
Antenna information	Round horn radiator with corrective lens that provides a half-power beamwidth of 12 degrees and a gain of +22.6 dBi. The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator.

3.5 Product description and theory of operation

The major components of the Ka-Band Antenna Unit are an antenna, a turnstile duplexer/polarization converter, a Gunn diode oscillator and associated temperature compensated voltage regulator, a passive quadrature balanced mixer and low noise IF (base band) pre-amps, a dual channel analog signal-conditioning circuit board, and a digital interface circuit board.
The antenna is a round horn radiator with corrective lens that provides a half-power beamwidth of 12 degrees and a gain of +22.6 dBi. The circular polarized transmit and receive signals are converted to rectangular polarization by a turnstile duplexer which also provides isolation between the transmit and receive ports to prevent receiver overload from the high level transmit signal. The transmit and receive ports are short sections of rectangular WR-28 waveguide that connect respectively to the Gunn oscillator and quadrature balanced mixer.
A high Q waveguide cavity resonator is the primary frequency-determining element in the Gunn oscillator. A mechanical ceramic-rod slug tuner is used to set the oscillator frequency, and to provide temperature compensation to correct frequency drift due to thermal expansion of the resonator cavity. The voltage regulator for the Gunn oscillator is also temperature compensated to reduce variations in power output with temperature and maintain operation at the peak power point of the Gunn diode. Frequency stability is ±100 MHz from -30 to +70 degrees centigrade. Nominal power output is 25 milliwatts and is specified and tested to be no less than 10 nor greater than 50 milliwatts over the full frequency and temperature range of the unit. FCC rules do not specify power limits for this type of equipment, but common practice utilizes power levels in the 10 to 100-milliwatt range which results in target detection range of 1/2 to 1 1/2 miles, depending on the radar cross section of the target. No means is provided for adjusting power output except for setting the voltage regulator to the peak power point for the particular Gunn diode being used. DC power consumption is typically 5.0 volts at 350 mA and is not adjustable beyond setting the peak power voltage.
The mixer is a passive quadrature balanced mixer using microstrip techniques. A branch coupler hybrid provides isolation between the received-signal port and the local oscillator port to prevent interaction and provides two outputs with equal amplitudes and 180-degree phase difference to drive the two mixer diodes in each mixer. The two mixers operate with a 90-degree phase differential to produce the quadrature output signals required for direction sensing. Local oscillator injection of approximately 1 milliwatt is provided to each mixer by a sampling probe in the waveguide section connected to the Gunn oscillator, and received signal is obtained from a waveguide to microstrip transition from the received-signal waveguide. Since the local oscillator injection is a sample of the transmitted signal, local oscillator leakage is not a problem. The demodulated Doppler signals have a bandwidth of 0 to approximately 20 kHz. These signals are amplified by a pair of low noise preamplifiers constructed on the same circuit board as the microstrip mixer, and these signals are then coupled to the analog circuit board of the specific product in which the antenna is used.

3.6 EUT exercise details

EUT was turned on, transmission was enabled and spectrum analyzer was tuned to a fundamental frequency

3.7 EUT setup diagram

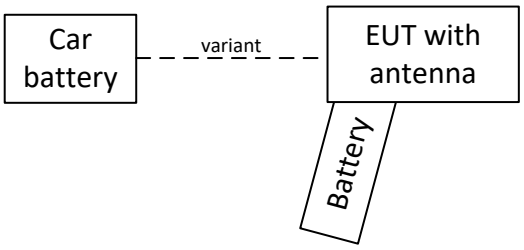


Figure 3.7-1: *Setup diagram*

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

Temperature	15–30 °C
Relative humidity	20–75 %
Air pressure	860–1060 mbar

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of K = 2 with 95% certainty.

Test name	Measurement uncertainty, dB
All antenna port measurements	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	Dec. 01/17
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	Jan. 07/17
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	Apr. 15/17
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	Apr. 28/17
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	Apr. 26/17
Pre-amplifier (1–18 GHz)	JCA	JCA118-503	FA002091	1 year	April 26/17
Pre-amplifier (18–26 GHz)	Narda	BBS-1826N612	FA001550	—	VOU
Pre-amplifier (26–40 GHz)	Narda	DBL-2640N610	FA001556	—	VOU
Horn antenna 18–40 GHz	EMCO	3116	FA001847	1 year	Apr.15/17
40–60 GHz Harmonic mixer	OML	WR19 M19HWD	FA002322	3 year	May. 16/19
40–60 GHz Standard gain horn	Millitech	U SGH-19	FA002322	—	VOU
60–90 GHz Harmonic mixer	OML	WR12 M12HWD	FA001524	3 year	May. 16/19
60–90 GHz Standard gain horn	Millitech	U SGH-12	FA001524	—	VOU
90–140 GHz Harmonic mixer	OML	WR08 M08HWD	FA001525	3 year	May. 16/19
90–140 GHz Standard gain horn	Millitech	U SGH-08	FA001525	—	VOU
140–220 GHz Harmonic mixer	OML	WR05 M05HWD	FA001526	3 year	May. 16/19
140–220 GHz Standard gain horn	Millitech	U SGH-05	FA001526	—	VOU
Temperature chamber	Espec	EPX-4H	FA002735	1 year	Jan 26/17

Notes: NCR - no calibration required, VOU - verify on use

Section 8. Testing data

8.1 FCC 2.1046 Output power

8.1.1 Definitions and limits

For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in §2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

8.1.2 Test summary

Verdict	Pass				
Test date	January 5, 2017	Test engineer	Andrey Adelberg		
Temperature	20 °C	Relative humidity	31 %	Air pressure	1015 mbar

8.1.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Detector mode:	Peak
Trace mode:	Max Hold

8.1.4 Test data

Table 8.1-1: *EIRP measurement results*

Frequency, GHz	Field strength, dBµV/m	Substitution factor, dB	EIRP, dBm	EIRP, W
34.7	144.39	95.23	49.16	82.413

Table 8.1-2: *Output power calculation results*

Frequency, GHz	EIRP, dBm	Antenna gain, dBi	Output power, dBm	Output power, W
34.7	49.16	22.60	26.56	0.453

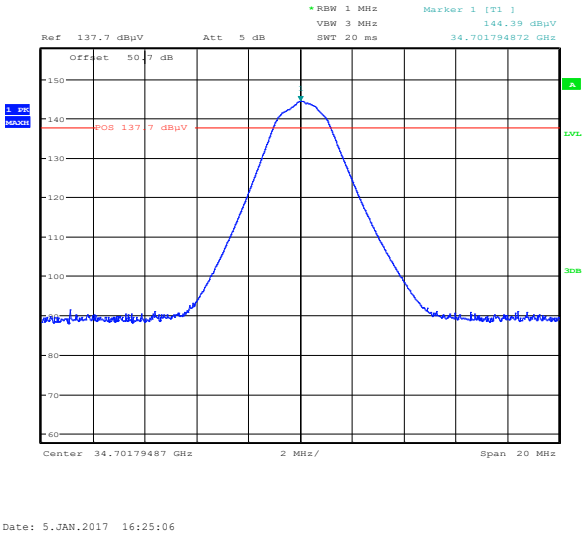


Figure 8.1-1: *Field strength of fundamental*

8.2 FCC 2.1049 Occupied bandwidth

8.2.1 Definitions and limits

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission.
Emission bandwidth must be within assigned band.

Table 8.2-1: *§90.103(b) Radiolocation service frequency table*

Frequency band, MHz	Channel spacing, kHz
0.07–0.09	Radiolocation land or mobile
0.09–0.11	Radiolocation land
0.11–0.13	Radiolocation land or mobile
1.705–1.715	Radiolocation land or mobile
1.715 to 1.8	Radiolocation land or mobile
1.9 to 2.0	Radiolocation land or mobile
3.23–3.4	Radiolocation land or mobile
420–450	Radiolocation land or mobile
2 450–2 500	Radiolocation land or mobile
2 900 to 3 650	Radiolocation land or mobile
5 250 to 5 650	Radiolocation land or mobile
8 500 to 10 550	Radiolocation land or mobile
13 400 to 14 000	Radiolocation land or mobile
15 700–17 300	Radiolocation land or mobile
24 050–24 250	Radiolocation land or mobile
33 400–36 000	**Radiolocation land or mobile**

8.2.2 Test summary

Verdict	Pass				
Test date	January 5, 2017	Test engineer	Andrey Adelberg		
Temperature	20 °C	Relative humidity	31 %	Air pressure	1015 mbar

8.2.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth:	≥1 % of span
Video bandwidth:	≥3 × RBW
Detector mode:	Peak
Trace mode:	Max Hold

8.2.4 Test data

Table 8.2-2: *99% occupied bandwidth results*

Frequency, GHz	99% occupied bandwidth, kHz
34.7	256.4

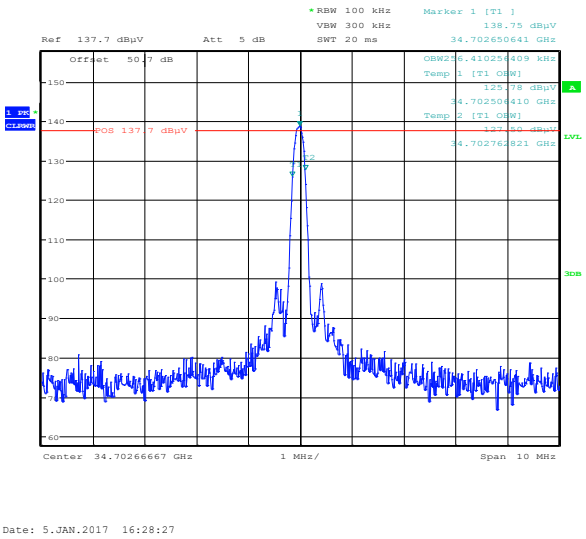


Figure 8.2-1: *99% occupied bandwidth*

100% occupied bandwidth is fully located within the assigned transmit band of 33.4 to 36.0 GHz.

8.3 FCC 2.1053 Field strength of spurious radiation

8.3.1 Definitions and limits

(a) Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of §2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required; with the measuring instrument antenna located in the far field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections, which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from half wave dipole antennas.
(b) The measurements specified in paragraph (a) of this section shall be made for the following equipment:
(1) Those in which the spurious emissions are required to be 60 dB or more below the mean power of the transmitter.
(2) All equipment operating on frequencies higher than 25 MHz.
(3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.
(4) Other types of equipment as required, when deemed necessary by the Commission
FCC 90.210. Except as indicated elsewhere in this part, transmitters used in the radio services governed by this part must comply with the emission masks outlined in this section. For “all other bands” the Mask for equipment without audio low pass filter is C
(c) Emission Mask C. For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows:
(1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5 kHz, but not more than 10 kHz: At least 83 log (fd/5) dB;
(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 10 kHz, but not more than 250 percent of the authorized bandwidth: At least 29 log (fd2/11) dB or 50 dB, whichever is the lesser attenuation;
(3) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

Table 8.3-1: *Field strength of spurious radiation limit*

Frequency range, GHz	Attenuation below carrier, dB	ERP of spurious emissions, dBm
0.03–220	43 + Log_{10} (P)	–13

8.3.2 Test summary

Verdict	Pass				
Test date	January 5, 2017	Test engineer	Andrey Adelberg		
Temperature	20 °C	Relative humidity	31 %	Air pressure	1015 mbar

8.3.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 220 GHz.
Radiated measurements were performed at a distance of 3 m for frequencies below 18 GHz, and 30 cm within 18–60 GHz and 3 cm above 60 GHz.

Spectrum analyser settings for radiated measurements within restricted bands below 1 GHz:

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for peak radiated measurements within restricted bands above 1 GHz:

Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Detector mode:	Peak
Trace mode:	Max Hold

8.3.4 Test data

No spurious emissions other than those listed in the table below were detected above the instrument noise floor.

Table 8.3-2: *Radiated field strength of spurious emissions*

Frequency, GHz	Peak Field strength[1] dBµV/m	Substitution factor, dB	EIRP, dBm	Limit dBm	Margin dB
69.40	78.77	95.23	-16.46	-13.00	3.46

Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

[1]The 3 cm measured field strength result was distance-corrected to 3 m as follows:

118.77 dBµV/m @ 3 cm − 20 × $\log_{10}$ (3 cm / 300 cm) = 118.77 dBµV/m @ 3 cm − 40 dB = 78.77 dBµV/m @ 3 m

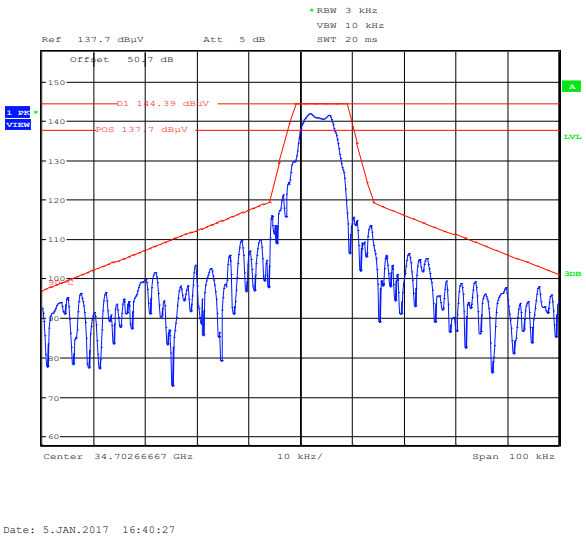


Figure 8.3-1: *Emission mask C*

8.4 FCC 2.1055 Frequency Stability

8.4.1 Definitions and limits

(a) The frequency stability shall be measured with variation of ambient temperature as follows:

(1) From −30° to +50° centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.

(2) From −20° to +50° centigrade for equipment to be licensed for use in the Maritime Services under part 80 of this chapter, except for Class A, B, and S Emergency Position Indicating Radiobeacons (EPIRBS), and equipment to be licensed for use above 952 MHz at operational fixed stations in all services, stations in the Local Television Transmission Service and Point-to-Point Microwave Radio Service under part 21 of this chapter, equipment licensed for use aboard aircraft in the Aviation Services under part 87 of this chapter, and equipment authorized for use in the Family Radio Service under part 95 of this chapter.

(3) From 0° to +50° centigrade for equipment to be licensed for use in the Radio Broadcast Services under part 73 of this chapter.

(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.

(c) In addition to all other requirements of this section, the following information is required for equipment incorporating heater type crystal oscillators to be used in mobile stations, for which type acceptance is first requested after March 25, 1974, except for battery powered, hand carried, portable equipment having less than 3 watts mean output power.

(1) Measurement data showing variation in transmitter output frequency from a cold start and the elapsed time necessary for the frequency to stabilize within the applicable tolerance. Tests shall be made after temperature stabilization at each of the ambient temperature levels; the lower temperature limit, 0° centigrade and +30° centigrade with no primary power applied.

(2) Beginning at each temperature level specified in paragraph (c)(1) of this section, the frequency shall be measured within one minute after application of primary power to the transmitter and at intervals of no more than one minute thereafter until ten minutes have elapsed or until sufficient measurements are obtained to indicate clearly that the frequency has stabilized within the applicable tolerance, whichever time period is greater. During each test, the ambient temperature shall not be allowed to rise more than 10° centigrade above the respective beginning ambient temperature level.

(3) The elapsed time necessary for the frequency to stabilize within the applicable tolerance from each beginning ambient temperature level as determined from the tests specified in this paragraph shall be specified in the instruction book for the transmitter furnished to the user.

(4) When it is impracticable to subject the complete transmitter to this test because of its physical dimensions or power rating, only its frequency determining and stabilizing portions need be tested.

(d) The frequency stability shall be measured with variation of primary supply voltage as follows:

(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

(2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point, which shall be specified by the manufacturer.

(3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

(e) When deemed necessary, the Commission may require tests of frequency stability under conditions in addition to those specifically set out in paragraphs (a), (b), (c), and (d) of this section. (For example measurements showing the effect of proximity to large metal objects, or of various types of antennas, may be required for portable equipment.)

8.4.2 Test summary

Verdict	Pass				
Test date	January 5, 2017	Test engineer	Andrey Adelberg		
Temperature	20 °C	Relative humidity	31 %	Air pressure	1015 mbar

8.4.3 Observations, settings and special notes

None

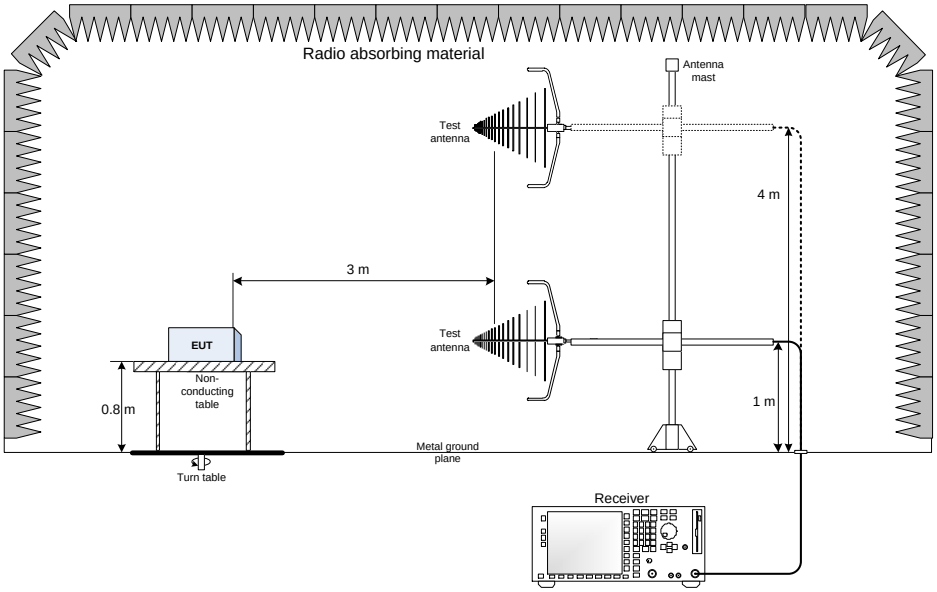
8.4.4 Test data

Table 8.4-1: *Frequency drift measurement*

Test conditions	Frequency, GHz	Drift, MHz	Drift, ppm
+50 °C, Nominal	34.64766843	-55	-1585
+40 °C, Nominal	34.66466843	-38	-1095
+30 °C, Nominal	34.66866843	-34	-980
+20 °C, +15 %	34.68266843	-20	-576
+20 °C, Nominal	34.702668429	*Reference*	*Reference*
+20 °C, −15 %	34.69866843	-4	-115
+10 °C, Nominal	34.71566843	13	375
0 °C, Nominal	34.71366843	11	317
−10 °C, Nominal	34.75166843	49	1412
−20 °C, Nominal	34.75166843	49	1412
−30 °C, Nominal	34.75366843	51	1470

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz